CHAPTER 5

STUDIES AND MONITORING

Since 1951, an intensive environmental surveillance program has been conducted at the Savannah River Plant (SRP). This program involves monitoring the compositions of effluents from SRP facilities, measuring radioisotope and chemical concentrations in the SRP environs, assessing the ecological health of the overall SRP environment, and determining SRP compliance with applicable standards. Analytical studies supplement the measurements and yield assessments of the impacts of operations. The results of this environmental program are reported annually to the public (e.g., Zeigler et al., 1986; Zeigler et al., 1987). J-38

The SRP environmental monitoring program for radioactivity is one of the largest and most comprehensive in the United States. In recent years, monitoring has been performed in a 5180-square-kilometer area in the immediate vicinity of the Plant, and representative samples were collected from an additional 77,700-square-kilometer area. In this entire area of 82,880 square kilometers, 20 types of samples were collected and analyzed for all types of radioactivity. In 1985, approximately 65,000 analyses were performed on 15,000 samples; in 1986, 85,000 determinations were performed on 15,000 samples. E-156 Approximately 480,000 samples and 1,770,000 analyses have been generated since the environmental radioactive monitoring program began in 1951 J-38 (Du Pont, 1985a; Zeigler et al., 1986; Zeigler et al., 1987).

The environmental surveillance program includes the monitoring of onsite and offsite air, water from SRP streams and the Savannah River, SRP groundwater, and samples of soil, vegetation, food, drinking water, animals, and fish for their radionuclide content. In addition, the U.S. Department of Energy's (DOE's) Remote Sensing Laboratory conducts periodic aerial radiological surveys of the Plant and surrounding areas. The South Carolina Department of Health and Environmental Control (SCDHEC) and the Georgia Department of Natural Resources (GDNR) also conduct independent radiological monitoring programs in the vicinity of the SRP (DOE, 1984a). A comprehensive evaluation of the SRP radiological monitoring program was conducted in 1986 by John E. Till, E-156 Ph.D., of Radiological Assessments Corporation. Recommendations from this reviewer have contributed to the 1986 program (Zeigler et al., 1987).

In addition to monitoring for radioactivity, the Plant monitors the physical properties (e.g., temperature) and nonradioactive chemical and metal content of liquid effluents, streams, groundwater, and the Savannah River. It also monitors drinking water, sediment, and air for potential contaminants. This program generated approximately 4000 samples and 40,000 analyses in 1985; in 1986, 4,000 samples were analyzed. The SRP laboratories performed some of the analyses, but offsite commercial laboratories have performed most groundwater E-156 and liquid effluent discharge nonradioactive analyses; a review of the nonradiological monitoring program was conducted by International Technology Corporation in late 1986 (Du Pont, 1985a; Zeigler et al., 1986; Zeigler et al., 1987).

The following sections describe recent studies and monitoring activities associated with the management of wastes on the Plant. (For details of other

J-38 studies and monitoring programs, see Du Pont, 1985a; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987; GDNR, 1983; and SCDHEC, 1983.)

5.1 MONITORING REQUIREMENTS AND COMMITMENTS

Many of the monitoring activities and studies are in response to specific regulations and DOE commitments. For example, the South Carolina Hazardous Waste Management Regulations (SCHWMR) require groundwater monitoring at the F- and TC H-Area seepage basins, and the M-Area settling basin. Specifically, the uppermost aquifer must be monitored with at least one upgradient and three downgradient wells. Table 5-1 lists the three classes of monitored parameters and the sampling frequencies. The groundwater surface elevation must be determined each time a sample is taken. A groundwater sampling and analysis plan must be developed to guide these activities. This plan must include sample collection, preservation, and shipment techniques; analytical procedures; and chain-of-custody controls.

The SCHWMR and the Resource Conservation and Recovery Act (RCRA) require detection and compliance monitoring of groundwater. Detection monitoring is performed to determine if contaminants have been introduced into the groundwater as a result of waste management facility operation. It involves a statistical evaluation of the quality of groundwater upgradient and downgradient from the facility. Such monitoring is performed at both an upgradient location and at a compliance point, a specific location at which concentrations of contaminants cannot exceed established limits. If statistically significant contamination is detected, compliance monitoring is TE initiated to assess whether the contamination exceeds the established limits. If it does, and if the exceedance can be traced to releases from the facility, corrective action will be taken to reduce concentrations to comply with the appropriate standards.

On November 7, 1985, representatives of DOE and SCDHEC signed Administrative Consent Order 85-70-SW. In signing this consent order, DOE committed to the following studies and monitoring activities:

- Complete installation of monitoring wells at the compliance points at M-, F-, and H-Areas within 120 days of SCDHEC approval of locations, depths, and construction, but no later than the date specified by the SCDHEC in its approval of the Part B Permit Application. The locations, depths, and construction are to be in accordance with the requirements of SCHWMR for compliance-point monitoring wells.

- Submission of quarterly status reports on M-, F-, and H-Areas, summarizing the results of determinations made under SCHWMR. The SCDHEC will approve or comment on each report within 30 days of receipt.

Another DOE commitment concerns the funding and implementation of the Groundwater Protection Plan for the SRP pursuant to Public Law 98-181: all groundwater mitigation proposals will be subject to the National Environmental Policy Act (NEPA) review process.

Public Law 98-181 (DOE, 1984b, Appendix A), enacted in November 1983, required TE discontinuing use of the settling basin in the M-Area of the Savannah River

Table 5-1. South Carolina Hazardous Waste Management Regulations: Groundwater-Monitoring Analyses[a]

Parameter	Collection frequency	Concentration limit[b]
	DRINKING WATER	
Arsenic	Quarterly for first year	0.05
Barium		1.0
Cadmium		0.01
Chromium		0.05
Fluoride		1.4-2.4
Lead		0.05
Mercury		0.002
Nitrate-nitrogen		10
Selenium		0.01
Silver		0.05
Endrin		0.0002
Lindane		0.004
Methoxychlor		0.1
Toxaphene		0.005
2,4-D		0.1
2,4,5-TP Silvex		0.01
Radium		5 pCi/liter
Gross alpha		15 pCi/liter
Gross beta		4 mrem/yr
Turbidity		1 TU
Coliform bacteria		1 per 100 ml
	GROUNDWATER QUALITY	
Chloride	Quarterly for first year; at least annually thereafter	None
Iron		
Manganese		
Phenols		
Sodium		
Sulfate		
	GROUNDWATER CONTAMINATION	
pH	Quarterly for first year; at least semi-annually thereafter	None
Specific conductance		
Total organic carbon		
Total organic halogen		

[a]SCHWMR R.61-79.265.90-.94
[b]In milligrams per liter unless otherwise indicated.

Plant within 2 years of the date of enactment and developing a plan for protecting groundwater at the Plant. The purpose of the plan was to identify components of the groundwater-protection program, as mandated by Public Law
TE 98-181. It includes the schedule for discontinuing the use of the M-Area settling basin; provisions for discontinuing the use of seepage basins associated with F- and H-Areas; provisions for the implementation of other actions to mitigate any significant adverse effects of onsite or offsite groundwater and of chemical contaminants in seepage basins and adjacent areas, including the removal of such contaminants where necessary; and provisions for continuing the expanded program of groundwater-impact monitoring, in consultation with the appropriate South Carolina agencies (DOE, 1984b).

In response to commitments made in the GWPP, DOE has accomplished the following:

- Discontinued the use of the M-Area settling basin (DOE, 1985a)

TE

- Completed the M-Area effluent-treatment facility (ETF)

- *Initiated cleanup of volatile organic compounds in the M-Area groundwater* (DOE, 1985a) via groundwater recovery wells and an air stripper

- Submitted a preliminary engineering report for the F- and H-Area ETF

- Completed a report describing the hydrogeology of the Plant and identified groundwater contamination (Du Pont, 1983)

- Developed an implementation plan for mitigation actions at those waste sites discussed in the preceding item (DOE, 1984b, Appendix D)

TC

- Completed the SRP Baseline Hydrogeologic Investigation (Bledsoe, 1984; Bledsoe, 1987; Zeigler et al., 1986).

An SRP Baseline Hydrogeologic Investigation Program has been implemented to address the stratigraphic and hydrogeologic data needs of the Plant. The immediate objective of this program is the installation of 18 clusters of approximately 8 wells each at key locations across the Plant. The wells will (1) provide information on the lithology, stratigraphy, and hydrogeology of the Plant, and (2) serve as high-quality observation wells for monitoring the groundwater quality, hydraulic-head relationships, gradients, and flow paths, and for tracking parameter changes as water use changes on and off the Plant.

The program has three phases:

- Phase I (completed 1984) - installation of 20 observation wells at 3 cluster sites

- Phase II (completed 1985) - installation of 56 observation wells at 8 cluster sites

TC

- Phase III (completed 1987) - installation of a total of 132 wells

Phases I and II concentrated on the collection of data from SRP areas on which little or no data existed. Phase III is designed to fill data gaps. The benefit of the entire program will be the establishment of a reliable, high-quality SRP hydrogeologic data base (Bledsoe, 1984; Bledsoe, 1987; Zeigler et TC
al., 1986).

5.2 EXISTING WASTE SITE MONITORING

The groundwater underlying the Plant is subject to a continuing program of analysis for radioactive and nonradioactive constituents. Many monitoring wells have been installed in the water-table and underlying aquifers at waste disposal sites to gather information about the fate of materials discarded at these sites (Du Pont, 1983).

Several improvements were made in well construction and sampling technique in 1984 and 1985. In 1984, pumps were installed to provide adequate flushing of wells before sampling. In addition, all samples for metals analyses were filtered before preservation (40 CFR 136). These steps were taken because C-52
results indicated that inadequate flushing and particulate matter in the samples analyzed for metals were contributing to the questionable results that had been obtained previously (Zeigler, Lawrimore, and O'Rear, 1985).

In 1985, galvanized well casings were removed from service and replaced by polyvinyl chloride (PVC) casings. Galvanized casings contributed to apparent contamination by several metals (zinc, cadmium, lead, and iron). Subsequent sample analyses have confirmed this relationship (Zeigler et al., 1986).

Groundwater from 325 wells is monitored at 59 potential hazardous and mixed TC
waste management facilities and miscellaneous sites (Zeigler et al., 1987). SCDHEC has approved 4 of the 46 locations as interim-status hazardous waste management facilities. Three of the four are seepage basins (F-Area, three basins; H-Area, four basins; and M-Area, one basin and a lake) that have been used for many years to dispose of wastewater containing a variety of industrial chemicals. TC

Contamination of plants can result from the absorption of radioactive materials from the soil or from radioactivity deposited from the atmosphere. Soil and grass (generally bermuda) are analyzed routinely for radioactivity because of their year-round availability and large surface coverage.

Table 5-2 summarizes the availability and quantity of groundwater monitoring and soil sampling data at existing waste sites. The Environmental Information Documents (EIDs) with their corresponding source document numbers (DPST 688-713) are given for reference. The number of sites in each functional group is given, along with the dates that site activity ended. The number and TC
types of monitoring wells and the year of beginning monitoring and frequency of sampling are shown. Soil sampling information is given as is an abbreviated list of chemical and radioactive constituents selected for analysis/assessment in the EIS (Looney et al., 1987).

Table 5-2. Existing Waste Sites Availability of Groundwater Monitoring and Soil Sampling Data

Waste site functional grouping	DPST No.	Total no. of sites	Well Sampling: Date closed	Well Sampling: Number of wells	Well Sampling: Date begun	Well Sampling: Frequency(c)	Soil sampling	Selected constituents for EIS analysis	Comments
SRL Seepage Basins	688	4	10/82	9	1982	Q	1983 Soil Cores	Heavy metals, F, Na, PO_4, H-3, and other radionuclides	Basin 4 is dry
Metallurgical Laboratory Basin	689	1	11/85	3	1984	Q	Extensive	Cr, Pb, Hg, VOCs	
Burning/Rubble Pits	690	15	1973-81	60	1984	Q	None	Cr, Pb, Na, VOCs	4 wells at each pit
Metals Burning Pit/Misc Chem Basin	691	2	1974	4 & 0	1983-84	Q	None - Metal Pit, cores at Chem Basin	VOCs	Wells at Metal Pit
Old F-Area Seepage Basin	692	1	5/55	4	1984	Q	4 Sediments 1986	Ba, Cd, Cr, Pb, Hg, NO_3, Na, TCE, Sr-90, Y-90, U-238, Pu-239	
Separations Area Retention Basins	693	2	1973	2 in H-Area	1984	Q	Sediments F & H	Sr-90, Cs-137, Pu-238	No wells in F-Area
Radioactive Waste Burial Grounds	694	3	Open	(a)	1970s	(a)	Soils & lysimeters	Cd, Pb, Hg, VOCs, radionuclides	643-G - closed in 1972
Bingham Pump Outage Pits	695	7	1957-58	None	-	-	None	Co-60, Sr-90, Cs-137, Pm-147	
Hydrofluoric Acid Spill Area	696	1	Spill Area	4	1985	Q	None	Pb, F	Spill uncertain
SRL Oil Test Site	697	1	Test Site	None	-	-	Extensive	None; test plots for biodegradation	Testing planned in 1987
New TNX Seepage Basin	698	1	Open	4(b)	1980-83	Q	Sediments 1985	Ba, Ni, Cr, NO_3, PO_4, Na, U^n, VOCs	
Road A Chemical Basin	699	1	1973	4	1983-84	Q	None	Pb, U-238	
L-Area Oil & Chemical Basin	700	1	1979	4	1982	Q	Soil Cores 1985	Cd, Cr, Pb, Hg, Ni, VOCs, H-3, and other nuclides	
Waste Oil Basins	701	2	D-Area 1975	6 and 2	1984	Q	None	Tetrachloroethylene - D-Area, Motor shop - none	Motor shop closed in 1983
Silverton Road Waste Site	702	1	1974	16(d)	1981-84	Q	Soils in 1983	Pb, VOCs	

Footnotes on last page of table.

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Table 5-2. Existing Waste Sites Availability of Groundwater Monitoring and Soil Sampling Data (continued)

Waste site functional grouping	OPST No.	Total no. of sites	Well sampling: Date closed	Well sampling: Number of wells	Well sampling: Date begun	Well sampling: Frequency(c)	Soil sampling	Selected constituents for EIS analysis	Comments
M-Area Settling Basin & Vicinity	703	2	1984	8-RCRA	1982	Q	Extensive	Ba, Cd, Cr, Cu, CN, Pb, Hg, Ni, NO_3, EHP, PO_4, PCB, Ag, Na, U^d, VOCs, Zn	Remedial action in 1985
F-Area Seepage Basins	704	3	Open	13-Rad 17 RCRA	1981-82 1981-84	Q	Soil in 1971 & 1984	Ba, Cd, Cr, Pb, Hg, NO_3, Na, PO_4, H-3, and other nuclides	
Acid/Caustic Basins	705	6	1982	20	1984-85	Q	Sediments in 1985	As, Cr, Cu, Se, Hg, VOCs, Na, PO_4, SO_4	No wells in H-Area
H-Area Seepage Basins	706	4	3 Open	28 RCRA 16 Rad	1981-82	Q	Extensive	Cd, Cr, Pb, Hg, Ag, NO_3, Na, H-3, and other nuclides	1 basin inactive 1962
Reactor Seepage Basins	707	7	K-Area 1960	39-R-Area 4-K-Area	1958	Q	K-Area 1 core, R-Area 9	H-3, Co-60, Sr-90, Cs-137, Pm-147, Pu-239	R-Area closed 1964
Ford Building Waste Site	708	1	Uncertain	None	-	-	None	None	Nearby wells
Ford Building Seepage Basin	709	1	1984	5	1984	Q	Soil cores 1985	Pb, Hg, Cr, PO_4, alpha, Co-60, Cs-137, Sr-90, Eu-155, H-3	
Old TNX Seepage Basin	710	1	1980	7	1980-85	Q	Sediments, delta and basin	Cr, Ag, Ni, Hg, Pb, NO_3, VOCs, H-3, Th-232, U-235, U-238	
TNX Burying Ground	711	1	1953	None	-	-	None	Uranyl nitrate	Explosion in 1953
CMP Pits	712	7	1979	7 21	1975-79 1982-84	Q	Shallow and deep cores	Cr, Pb, Zn, pesticides, VOCs, including benzene	Excavated in 1984, 7 wells grouted
Gun Site 720 Rubble Pit	713	1	Unknown	None	-	-	None	None	No records

[a]Numerous grid, monitoring, trench and borehole wells have been installed since the early 1970s. See Jaegge et al., 1987, for details.
[b]Original 4 wells were replaced in 1983.
[c]Q = quarterly.
[d]Includes clusters of wells.
U^n = Natural uranium
U^d = Depleted uranium
VOC = Volatile organic compounds
EHP = Bis-2-ethyl hexyl phosphate
TCE = Trichloroethylene
PCB = Polychlorinated biphenyl

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5.2.1 F- AND H-AREAS

TC Routine environmental monitoring is conducted at the F- and H-Area seepage basins (Ashley, Padezanin, and Zeigler, 1984; DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). For radiation monitoring, composite samples of the influent flow of the basins are taken from the flow proportional continuous monitor once a week. In addition, dip samples from the basins and groundwater monitoring well samples are taken once a quarter. The vegetation surrounding the basins is sampled once a year. Each sample is analyzed for gross alpha and beta, gamma spectrum, and strontium-89 and -90. The radioactivity released to the seepage basins is reported in the Health Protection Monthly Radioactive Release Report.

TC Monitoring wells were installed in 1951. These wells are used to measure water-table elevations in the Separations Area. They are also used to monitor any groundwater contamination in the vicinity of F- and H-Areas. These wells are sampled for radioactivity and for Primary Drinking-Water Standard metals (Zeigler et al., 1986; Zeigler et al., 1987).

Soil samples were collected from the four quadrants around the F- and H-Areas and at the SRP boundary. In addition, two control samples were taken approximately 160 kilometers from the SRP. Soil cores were composited by location and analyzed for plutonium-238 and -239, strontium-90, and gamma-emitting radionuclides (Zeigler et al., 1986; Zeigler et al., 1987). The migration of radioactivity from the F- and H-Area seepage basins was measured with continuous samplers and flow recorders in Four Mile Creek. Groundwater from the F-Area seepage basin flows to outcrops on Four Mile Creek (FM) between two sample locations.

Most of the H-Area seepage basin outcrop from basins 1 through 3 occurs between two sample locations. Additional outcrop from H-Area seepage basin 4 and the burial ground occurs between two other sample locations. The tritium from these two facilities mixes; beyond this mixing point the source of tritium cannot be determined.

F-Area Seepage Basins

J-38 In 1985, groundwater at the F-Area seepage basin was monitored routinely at eight wells and at nine wells in 1986. Two wells were nearly dry in 1986; no samples were analyzed (Zeigler et al., 1987). The radioactivity detected in seepage basin wells will be diluted by groundwater and eventually will either decay or flow with groundwater to Four Mile Creek. Acid, sodium, and nitrate have also been detected at the seepage basin compliance point; accordingly, detection monitoring has been replaced by compliance monitoring, as required by the SCHWMR and the RCRA.

H-Area Seepage Basins

Groundwater below the H-Area seepage basins was monitored routinely at 16 wells between the seepage basins and Four Mile Creek.

H-Area Retention Basins

In 1985, wells were installed around the two H-Area retention basins. No samples were collected at these wells in 1986 (Zeigler et al., 1987). J-38

5.2.2 RADIOACTIVE WASTE BURIAL GROUNDS

A program to monitor the migration of radionuclides from their storage locations has been under way since the startup of the waste-disposal/storage site. The U.S. Army Corps of Engineers installed the first monitoring wells (nine perimeter wells) in 1956. Monitoring has increased over the years of operation, and additional wells were installed in 1963 and 1969. In 1972 and 1973, 11 new wells were installed in this area; in 1975, 35 wells were installed at the perimeter of the burial ground (Buildings 643-G and 643-7G). Sixteen of the wells installed between 1963 and 1975 replaced the nine original perimeter wells. In 1978 and 1979, five new cluster wells were installed at the perimeter of the burial ground outside the fenced area. Groundwater at the burial ground is analyzed quarterly for alpha, nonvolatile beta, and tritium. Routine monitoring is performed at 16 wells inside the facility and 35 wells along the perimeter. In addition, there is an extensive grid monitoring system of 87 wells for migration and modeling studies (DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). J-38 J-38

The area around the waste monitoring trailer has a history of contaminated vegetation dating to 1965, when vegetation contaminated with strontium-89 and -90 was found. Soil core samples at that time indicated high concentrations of nonvolatile beta within 0.6 meter of the surface of the soil. The area was cleared of vegetation and treated with a herbicide at that time. J-38

During 1985, vegetation was collected inside the radioactive waste burial ground (Buildings 643-G and 643-7G). The samples were analyzed to determine if the vegetation had experienced a significant uptake of radioactivity from the waste buried there.

Vegetation collected from 51 locations inside the burial ground was composited by location for analysis. This collection method provides coverage of a large part of the facility while keeping the number of samples to a minimum. The samples were analyzed for alpha, nonvolatile beta, and gamma-emitting radionuclides (DOE 1985b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987). TC

In 1986, an extensive system of 87 groundwater monitoring wells was sampled for concentrations of alpha, nonvolatile beta, and tritium in the groundwater beneath the solid waste storage facility. Some of these wells are used for routine monitoring; others are used for research to determine possible migration pathways and for development of groundwater models (Zeigler et al., 1987). TC TC

5.2.3 REACTOR SEEPAGE BASINS

Groundwater is currently monitored at 70 wells in and around the reactor seepage basins and K-Area containment basin. Three wells in R-Area were dry in 1986 (Zeigler et al., 1986; Zeigler et al., 1987). J-38

In addition, vegetation samples were collected near each reactor seepage basin. Samples from a maximum of eight locations outside the fence of each seepage basin were composited for alpha, beta, strontium-89, and strontium-90 analyses (Zeigler et al., 1986).

5.2.4 M-AREA

J-38 Groundwater monitoring from over 200 wells is presently being performed at the M-Area settling basin. This monitoring is in response to the detection in 1984, 1985, and 1986 of halogenated organics, nitrate, and sodium (Zeigler et al., 1986; Zeigler et al., 1987).

5.2.5 OTHER MONITORING ACTIVITIES

Because the environmental monitoring program at the SRP is one of the largest and most comprehensive in the United States, this EIS cannot describe all of TC the studies and monitoring activities conducted on the SRP. (More information on such activities can be obtained from Du Pont, 1985a, b; Zeigler, Lawrimore, and O'Rear, 1985; Zeigler et al., 1986; Zeigler et al., 1987; GDNR, 1983; and SCDHEC, 1983.) However, in response to this EIS, the South Carolina Institute of Archaeology and Anthropology, University of South Carolina, conducted an intensive archaeological and historical survey of 82 existing hazardous, low-level radioactive, and mixed waste sites located in the upland sandhills zone of the SRP (Brooks, 1986). The Institute also carried out an intensive archaeological and historical survey and testing of six new low-level radioactive, hazardous, and mixed waste storage and disposal facilities located primarily in the same area (Brooks, Hanson, and Brooks, 1986).

5.2.5.1 Drinking-Water Monitoring

Communities near the Plant get drinking water from deep wells or surface-water bodies. Drinking-water supplies from 22 onsite facilities and 14 surrounding towns are sampled and analyzed for alpha, nonvolatile beta, and tritium. In addition, the SRP and SCDHEC routinely analyze water from 14 SRP drinking-water sources for the total number of bacteria multiplying at 35°C on an agar medium (standard plate count), total coliform bacteria, pH, and residual TC chlorine. They also analyze some systems for turbidity, hardness, and carbon dioxide (Zeigler et al., 1986; Zeigler et al., 1987).

5.2.5.2 Surface-Water Supplies

Two water treatment plants downstream from the Plant supply treated Savannah River water to customers in Beaufort and Jasper Counties, South Carolina, and in Port Wentworth, Georgia. The Beaufort-Jasper plant serves a consumer population of approximately 50,000. Treated water from the Port Wentworth plant is used primarily for manufacturing and other industrial purposes. The Port Wentworth water treatment plant has an effective consumer population of about 20,000.

Samples of raw and finished water at both plants are collected daily and composited for monthly alpha, nonvolatile beta, and tritium analyses. Additional monitoring of raw and finished water from the plants for low levels of cobalt-60 and cesium-137 is provided by continuous samplers. Results of 1985 analyses for alpha, nonvolatile beta, tritium, cobalt-60, and cesium-137 were reported quarterly to the plants and to the States of Georgia and South Carolina. SCDHEC performs independent tritium and nonvolatile beta analyses of water samples at the Beaufort-Jasper treatment facility. Results of these analyses are compared to SRP data. GDNR also collects drinking-water samples from the Port Wentworth facility monthly and analyzes them for alpha, nonvolatile beta, and tritium concentrations (DOE, 1984a; Zeigler et al., 1986; Zeigler et al., 1987). TC

5.2.5.3 Groundwater Supplies

The SRP collects groundwater samples from several monitoring wells and analyzes them for radioactivity (Du Pont, 1985a). The SCDHEC monitors for concentrations of alpha, nonvolatile beta, and tritium in groundwater from wells in six nearby communities and from additional wells around the Barnwell Nuclear Fuel Plant. The GDNR monitors for the same parameters at 10 Georgia locations. Both State programs are conducted quarterly (DOE, 1984a; Zeigler et al., 1986; Zeigler et al., 1987). TC

5.3 EXISTING WASTE SITES - FUTURE MONITORING

5.3.1 GROUNDWATER QUALITY ASSESSMENT PLAN

The Groundwater Quality Assessment Plan was designed to determine the extent, concentration, and rate of migration of hazardous waste constituents in the groundwater system. The plan involves monitor-well installation, water-quality sampling and analysis, hydrogeologic data collection, and data evaluation (Du Pont, 1985c).

5.3.1.1 M-Area Settling Basin

To define the extent and concentration of waste constituents in the groundwater at M-Area, a two-phase well-installation program was designed. Phase I, initiated in September 1984, consisted of the installation of 58 monitor wells in 15 clusters. The placement of the wells was designed to expand, horizontally and vertically, the existing monitoring network. The installation of the Phase I wells was completed in May 1985 (Du Pont, 1985c).

A hydrogeologic data collection program was incorporated as an integral part of the Groundwater Quality Assessment Plan (Du Pont, 1985c). The objectives of this program are to define the geometry of the pertinent hydrologic units at the site and to quantify the water retention and transmission characteristics of each unit. The hydrogeologic data collection program has three basic program elements: (1) geologic data collection and testing, (2) aquifer pump testing, and (3) potentiometric data collection.

The final element of the Groundwater Quality Assessment Plan is evaluation of the data. Graphic, analytic, and numeric techniques are used to determine the extent of groundwater contamination and the rates of contaminant migration. DOE submits annual reports of groundwater-quality assessment to SCDHEC. These assessment reports will propose and describe required additional studies.

5.3.1.2 F-Area Seepage Basins

In F-Area, 17 wells in 4 hydrogeologic zones will be monitored quarterly for the indicator parameters and groundwater-quality parameters listed in Table 5-1. All these parameters will be monitored annually. In addition, the indicator parameters will be monitored semiannually. This semiannual sampling will include nitrate and sodium. Other constituents identified as groundwater contaminants will be added to the monitoring program (Du Pont, 1985c).

This monitoring program will be used to detect any hazardous constituents that might enter the groundwater from the F-Area basins. Each quarter, the analyses will be studied for the appearance of hazardous constituents and changes in groundwater flow rate or direction. The annual groundwater-quality assessment reports will present the results. These reports will also propose and describe required studies (Du Pont, 1985c).

5.3.1.3 H-Area Seepage Basins

In H-Area, 28 wells in 4 hydrogeologic zones will be monitored quarterly for the indicator parameters and groundwater-quality parameters listed in Table 5-1, and for mercury, sodium, and nitrate. Other constituents identified as groundwater contaminants will be added to the monitoring program as identified (Du Pont, 1985c). The annual groundwater-quality assessment reports will present results of these analyses, along with information from F- and M-Areas. These reports will also describe additional studies or monitoring activities required.

5.3.2 MONITORING ASSOCIATED WITH WASTE MANAGEMENT FACILITY CLOSURE AND POSTCLOSURE

DOE submitted closure plans for the metallurgical laboratory basin (Du Pont, 1985d) and the mixed waste management facility (DOE, 1985c), and a postclosure permit application for the M-Area hazardous waste management facility (DOE, 1985a), to SCDHEC in 1985, in accordance with the SCHWMR. The following sections describe the monitoring commitments associated with these closure and postclosure plans.

5.3.2.1 Metallurgical Laboratory Basin

Monitoring commitments associated with closure of the metallurgical laboratory basin include the commitment to monitor wells 1A, 2, and 3A quarterly for the parameters listed in Table 5-1 (Du Pont, 1985d).

5.3.2.2 Mixed Waste Management Facility

The DOE will complete the following in conjunction with site closure: a borrow study to identify sources of material for the final cover; a compaction study to determine the physical characteristics of the waste and overburden; and studies of the effects of overburden on subsidence in the trenches (DOE, 1985c).

In addition, the DOE has proposed a detection monitoring program to determine if groundwater contamination is occurring. The proposed monitoring well system will determine the quality of both background groundwater (i.e., groundwater not affected by operations of low-level radioactive waste disposal facilities) and groundwater past the point of compliance. The monitoring of downgradient groundwater quality at the compliance point is required by RCRA.

The detection monitoring system will consist of 27 wells, including the upgradient wells. This system assumes three wells per cluster in the uppermost aquifer. Each cluster will have three screened zones with discrete functions: the uppermost screen will monitor the zone near the top of the water table; the middle screen will monitor the zone above the "tan clay" near the top of this subunit; and the bottom screen will monitor the lowermost strata of the aquifer near the top of the "green clay." The exact number of wells per cluster will be determined during drilling when the lithology has been assessed. To provide an accurate groundwater characterization, the background monitoring well cluster will be approximately 1370 meters from the mixed waste management facility. The remaining 24 detection monitoring wells will be downgradient wells (DOE, 1985c).

The detection well system will fulfill RCRA requirements. Data from the proposed well clusters will describe thoroughly the site hydrogeology in the uppermost aquifer for the mixed waste management facility.

5.3.2.3 M-Area Settling Basin and Lost Lake

Hazardous constituents have been detected during interim-status monitoring at the M-Area settling basin and Lost Lake. Therefore, detection monitoring is not applicable to this site, and compliance point monitoring will be performed (DOE, 1985a).

The groundwater monitoring well system will consist of nine downgradient wells grouped in three clusters, and one upgradient cluster of three wells. The upgradient well cluster will be 122 meters from the M-Area settling basin on the axis of the groundwater ridge. Because the M-Area basin is approximately 30 meters above the water table, leakage from the basin might cause water-table mounding beyond the areal limits of the basin. Placing the upgradient wells 122 meters from the basin will preclude facility-induced contamination (DOE, 1985a).

5.3.3 WASTE SITE CHARACTERIZATION PROGRAM

The Savannah River Laboratory is developing and implementing characterization programs for determining the extent of chemical and/or radionuclide contamination at SRP waste sites. The data collected from these programs will provide the technical basis for the final closure of these waste sites according to applicable State and Federal regulations. Characterization programs have been completed for the Savannah River Laboratory (SRL), M-Area, Old TNX, and metallurgical laboratory seepage basins and H-Area (for tritium in the Congaree Formation). Additional characterization programs are in progress for the L-Area oil and chemical basin and the Ford Building seepage basin and are planned for the New TNX seepage basin (Zeigler et al., 1986). A summary of 1986 activities is presented in Zeigler et al., 1987.

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5.4 *NEW DISPOSAL FACILITIES*

5.4.1 HAZARDOUS AND SOLID WASTE AMENDMENTS OF 1984

New landfills and surface impoundments, as well as replacement units and expansions of existing facilities, were required to meet minimum technological requirements (MTRs) after November 8, 1986. These requirements include a double liner, a leachate collection system, a leak detection system for new units after May 1987, and groundwater monitoring.

TC In February 1987, EPA issued proposed regulations for the monitoring and control of air emissions at hazardous waste treatment, storage, and disposal facilities. Such facilities include, but are not limited to, monitored retrievable storage facilities, surface impoundments, and landfills such as the new disposal facilities for low-level radioactive wastes and mixed wastes.

To comply with the HSWA, DOE submitted an Exposure Information Report (EIR) to SCDHEC and EPA in August 1985. The EIR contained information important to assessing the potential for exposure of the public to waste disposal in the interim-status facilities (Zeigler et al., 1986).

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5.4.2 PROPOSED MONITORING AT NEW DISPOSAL/STORAGE FACILITIES

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The groundwater monitoring system at the new disposal/storage facilities must permit determination of the impact of these facilities on groundwater in the aquifers above the Black Creek/Middendorf (Tuscaloosa). The system must have the following features: TC

- Well placement that will permit the collection of representative samples of groundwater, including groundwater upgradient from the facility
- Casings that will maintain the integrity of the monitoring-well bore
- Measures to prevent the contamination of groundwater samples

TE To meet these requirements, the monitoring system will consist of a series of well clusters spaced about every 46 meters at the boundary of a facility. The wells will have 6-meter screens placed at 15-meter depth intervals to the top of the Ellenton Formation (Cook, Grant, and Towler, 1987a, b). TE

The monitoring program will involve the collection of monthly samples from each monitoring position. The samples will be analyzed for chemical (inorganic and organic) and radionuclide species expected to be in the waste that is disposed of or stored in the facilities.

Surface water in the vicinity of the new storage and disposal facilities will be monitored for chemicals and radionuclides; it will consist of the rainwater runoff and standing water in streams that draw water from the land area around the facility. The storage and disposal facilities will have an engineered surface-water drainage system that will impound the water in one or more locations for monitoring and treatment, if needed, before releasing it to plant streams.

Air monitoring will be provided as needed, depending on the amount of rainfall in the area. Moreover, rainfall and air collection and monitoring systems will be in operation on the perimeter of the storage and disposal facilities. Such systems have been in use on the Plant for many years; they collect rainfall and examine it for radioactivity or collect air samples on filters and examine them (Cook, Grant, and Towler, 1987a, b). TE

5.5 ANALYTICAL STUDIES

Analytical studies are designed to use and supplement the data gathered in the monitoring studies described previously in this chapter. Such analytical studies can be used to increase knowledge of (1) the site, (2) the impacts of site operations on the environment, and (3) actions required to mitigate the environmental impacts of site operations. Appendix H contains details on the models used in this analysis and the basis for their selection.

5.5.1 GROUNDWATER-FLOW MODELING

The SRL manages the regional groundwater-flow modeling program. This program is a management tool that helps planners make decisions about groundwater resources at the Plant. Modeling is conducted in three phases (Zeigler et al., 1986):

- System conceptualization
- Model calibration
- Simulation

Under this program, a numerical groundwater-flow model was developed for a 78-square-kilometer area that underlies the A/M-Area. The purpose of this model is to predict and evaluate the efficacy of the groundwater remedial-action program. The model was used to simulate the flow patterns of groundwater and the effects of recovery-well operations on these patterns. After an initial model calibration, various pumping scenarios were examined. The results were used to relocate two perimeter wells of the recovery-well network to enhance chlorocarbon-plume capture. TE

5.5.2 ENVIRONMENTAL INFORMATION DOCUMENTS AND PATHRAE MODELING

For the preparation of this EIS, DOE requested E. I. du Pont de Nemours and Company (Du Pont) to provide technical support of groundwater modeling, human health risk assessment, and ecological impacts for the alternatives associated with the closure of hazardous, low-level radioactive, and mixed waste sites, and for the proposed new disposal/storage facilities. TE

Du Pont categorized the existing waste sites that were originally identified for inclusion in the EIS into 26 functional groupings. The technical approach involved preparing an Environmental Information Document (EID) for each of the 26 groupings (complete reference citations for the 26 EIDs are given in Appendixes B and E). Part I of each EID, which encompasses the nature of contaminant disposal, the geohydrologic setting, and waste site characterization, was completed in 1985. Part II, which includes estimates of environmental hazards associated with each closure option for each grouping, was completed late in 1986. Environmental Information Documents for the proposed new disposal

TC facilities were also prepared, as were EIDs related to transport modeling, chemical constituent selection, quality assurance, geochemical parameters, and human health effects.

The PATHRAE computer code was chosen to calculate the human health risks associated with the subsurface transport of contaminants for each alternative evaluated on a comparative basis. PATHRAE was originally developed for the EPA for performance assessment calculations at low-level radioactive waste disposal sites. The code has been modified to perform transport and risk calculations for nonradioactive constituents. Pathways modeled using PATHRAE include

- Groundwater to wells
- Groundwater to surface streams
- Waste erosion and movement to surface streams
- Consumption of food from a reclaimed farm over the waste site
- Consumption of crops from natural biointrusion into the basin
- Direct gamma exposure

Computer code calculations were also made to determine, for each waste site alternative, the risks to human populations from the atmospheric transport of contaminants. Atmospheric pathways evaluated include the inhalation of polluted air, the ingestion of contaminated foodstuffs by individuals and the offsite population, and the risks to occupational personnel from airborne contaminants generated during actual waste site closure operations. The computer codes used to model the atmospheric pathways are SESOIL, MARIAH, XOQDOQ, CONEX, TERREX, MILENIUM, MAXIGASP, and POPGASP (see Appendix H for more details).

5.5.3 TRANSPORT OF HEAVY METALS AND RADIONUCLIDES

Research continues on the development of a geochemical model for predicting the chemical speciation, mass transport, and fate of metals and radionuclides in aquatic systems on the Plant. The geochemical model MEXAMS (Metal Exposure Analysis Modeling System) has been installed on the site computer system. The basic components of MEXAMS are the geochemical model MINTEQ and an aquatic exposure assessment model, EXAMS. The interfacing of these two models provides information on the chemistry and behavior of metals, as well as the transport processes influencing their migration and ultimate fate in aquatic systems. Simulations for cadmium, copper, and nickel in SRP streams indicate
TC that the MEXAMS model will be a useful tool in predicting the transport and fate of metals (Zeigler et al., 1986; Zeigler et al., 1987).

5.5.4 ENVIRONMENTAL RADIOMETRICS

At present, a specially constructed ultra-low-level counting facility is being used to analyze concentrations of radioactive isotopes at environmental-background levels. Other analyses are being conducted to develop specific information about the transport and fate of long-lived radionuclides such as technetium, uranium, and plutonium. A state-of-the-art underground counting facility will improve sensitivity and sample processing.

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